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ABSTRACT

A study examined the impact of the Advanced Technological Education (ATE) program on efforts in academic and vocational integration. A case study of 10 community colleges housing ATE-funded projects collected data through interviews with administrators, faculty, ATE program practitioners, and faculty and administrators at collaborating high schools and 4-year institutions. Findings indicated two major approaches (content integration and process integration) were involved in ATE curriculum development; collaborations among faculty members were important to program quality and scope of dissemination; participation of technology/occupational faculty members was pervasive in development and dissemination of ATE-funded curriculum and other ATE activities; general education faculty participated far less; interactions between ATE-funded programs and non-credit-oriented workforce development programs were prevalent and increasing; barriers were tensions between ATE and academic departments and organizational issues like work arrangements; rapidly changing advanced technologies, industry needs and fiscal and programmatic restrictions led ATE toward non-credit, workforce development programs; and articulations were potentially possible, although students would need to take significant amounts of additional courses that are not general education or "applied." (Contains 37 references) (YLB)

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Integration of Vocational and Academic Curricula through the NSF Advanced Technological Education Program (ATE)

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BACKGROUND

During the last 15 years, scientists, business people, and educators have engaged in an extensive discussion on how education in science, technology, engineering and mathematics (STEM) needs to be improved. The impetus was a growing concern in the 1980s that American students were not prepared for the rapidly changing workplace, which concern was caused by increasing global competition and constant technological innovation (Bassi 1996; Committee for Economic Development 1985). Reformers concluded that STEM had to be more accessible to undergraduate students in the STEM area as well as to a broader clientele, since knowledge of technology is now necessary in many occupations (Advisory Committee to NSF 1996). Particularly emphasized was the fact that technical jobs typically filled by workers with a two-year college education required a stronger base of scientific and mathematical knowledge, and thus students in two-year college programs needed to be prepared to continue their education in four-year colleges as well as being prepared to go to work directly (Barley and Orr, 1997; SATA 1992). For these objectives to be met, more emphasis must be put on interdisciplinary curricula and the integration of academic and occupational instruction, and better articulation must be developed between the Associate and Baccalaureate degree levels.

By the mid-to-late 1990s the perspective that occupational education requires a stronger integration of academic and occupational studies was further emphasized among policymakers as well as educational reformers. The growing emphasis was reflected in federal reports and legislation in the 1990s including the SCANS report, Tech Prep, and Title III of the Perkins Vocational and Applied Education Act (1990 and 1998). Nonetheless, studies on the efforts of postsecondary occupational programs to respond to

federal legislation have reported a slow, often stagnant progress in such efforts. A study by the National Assessment of Vocational Education (NAVE), for instance, concluded that postsecondary vocational programs have not adopted integrated academic and vocational curricula as readily as has the secondary level (Boesel and McFarland 1994). Other studies have identified various barriers to disseminating the new pedagogical approaches, particularly to community colleges (Boesel 1994; Grubb, Badway, Bell and Kraskouskas 1996; Grubb and Stasz 1993). Obstacles to curriculum integration include a difference in culture between vocational and academic programs due to a longstanding separation between the two worlds (Conroy and Sipple 2001; Dougherty 1994) and the large amount of effort and expenditure needed to integrate instruction (Perin 1998). Also, efforts to assist more learners in moving from two-year to four-year institutions have met with strong resistance from college faculty, due partly to misalignment in curricular content and academic standards (Orr and Bragg 2001). These findings suggest that curriculum integration is not merely an issue of pedagogic innovation. Rather, it involves changes in organizational culture, resource management, and instructional alignment.

In light of this background, our study examines the impact of a recent federal initiative in the area of STEM education on efforts in academic and vocational integration – whether and how a specific national incentive has facilitated curriculum innovation and what obstacles are likely to impede the adoption and dissemination of such innovation. We highlight the Advanced Technological Education (ATE) program funded by the National Science Foundation (NSF)[1]. With an increasing need to better prepare the

[1] The ATE program was initiated in response to the Scientific and Advanced Technology Act (SATA) passed by the U.S. Congress in 1992. The program is a grant-based initiative that funds two-year colleges and their partners that conduct specific activities for the improvement of STEM education. Since the first

nation's mid-skilled technical workforce for a more technologically advanced and competitive economy, the ATE is geared specifically toward STEM programs in two-year colleges. The development and dissemination of innovative curricula is one of the major objectives of the program. Like other curriculum innovations over the past decade, the ATE program promotes a pedagogic reform that integrates academic and vocational curricula, with strong emphasis on articulated relationships with four-year colleges.

We thus see the ATE as an innovation that facilitates the integration of academic and applied curricula, as well as greater career opportunities for both work- and college-bound students. Our central questions then are: 1) whether, through the ATE program, the curriculum is indeed developed and implemented in a way that integrates academic and vocational education; 2) how the development and implementation of the ATE-funded curriculum impacts on transfers from two-year to four-year institutions; and 3) what are the barriers, if any, to the spread and development of integrated pedagogy as well as to articulations and transfers. To answer these questions, we have conducted in-depth interviews at ten two-year colleges that house the ATE program, with college faculty in both academic and occupational departments as well as college presidents and other administrators. The integration of academic and technical education requires inter-disciplinary activities including collaborations between technical and academic faculty, as well as inter-departmental course arrangements. This process potentially requires significant changes in the culture, policies and practices of college faculty and administrators that have long maintained a clear distinction between academic and vocational education. Through an intensive case study of the ten colleges, our

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ATE grant was awarded in 1994, more than 400 ATE grants have been awarded to post-secondary institutions. Approximately $260 million had been distributed by the end of 2001.

investigation thus focuses on the impact of the ATE program on the relationship between technical and academic departments as well as between faculty in technology and academic programs.

In this paper we first review the conceptual framework of academic and vocational education integration by referring to past studies and research results. After describing the data and research methodology that we used for this study, we will present our findings. We review specific activities in curriculum development, particularly focusing on how academic and occupational components are integrated in the process of curriculum development. We then examine the dissemination of the developed curriculum. The dissemination will be discussed in terms of how the ATE curriculum is being used in different college departments including vocational programs, academic departments, and non-credit based workforce development programs. We will then discuss factors that possibly impede the dissemination of integrated curriculum. We will go on to investigate how our findings in curriculum development and dissemination are related to issues in articulation and transfer to four-year programs. The paper will conclude with the summary, and the implications of the findings.

STUDIES ON CURRICULUM INTEGRATION

An integrated approach to teaching and learning is designed to strengthen the academic base of work-related skills, on the one hand; and to provide a context and motivation for learning academic skills, on the other (Bailey 1997, Brown 1998). This implies that the integrated approach involves reforms from two perspectives: one as an occupational reform, and another as a general pedagogic reform. In the area of

occupational programs, academic content is infused into technology instruction, aiming at developing thinking skills, decision-making, problem solving, and knowing how to learn, as well as basic academic skills (SCANS 1991). In the area of general education, the applied concept is integrated with the existing academic curriculum. The basic rationale is that students will learn better when courses are taught in a real-world context, by connecting the classroom to the workplace, and abstract concepts or knowledge to real problems (Keif and Stewart 1996, Marshal and Tucker 1992, Stasz 1997).

Several early psychologists such as Thorndike (1931) and Hull (1943) had already discussed the importance of associating different elements in learning. The recent cognitive theorists have added a constructivist dimension, contending that learning is a process of knowledge construction rather than knowledge memorization, absorption or storage (Beane 1998, Biggs, Hinton and Duncan 1996). This concept of the constructivist pedagogy reflects the philosophy on which academic and vocational integration is based: instruction has to forge connections between knowledge development and its application in the workplace (Brown 1998). In the area of STEM in particular, many educators believe that students in applied, as opposed to more abstract, courses learn more and take greater interest in the subject matter (Pedorotti and Chamberlain 1995; Myer, Dekker and Querelle 2001). Other studies report that students completing applied mathematics attain comparable skills to students completing academic algebra (CORD 1994; Tanner and Chism 1996).

Recent studies on the evolution of instructional reform however, have found various barriers to disseminating the new pedagogical approaches to both secondary and post-secondary schools. In early observations, on community colleges in particular,

Grubb and Stasz (1993) and Boesel (1994) report that community colleges have made little progress in implementing academic and vocational integration, partly because the idea was not disseminated enough. In a later study, Grubb (1999) found significant institutional barriers to the diffusion of innovative pedagogy. Some of the barriers can be explained by the nature of educational institutions where forces maintaining the status quo are always more powerful than the forces for innovation (Williams 1996). Other barriers exist in that externally initiated innovations often experience difficulty in generating local motivation among educators to sustain the initiative (Berman and McLaughlin 1978; McLaughlin 1990)

Critics argue that faculty and students in vocational programs have little or no interaction with faculty in the traditional academic areas or with students preparing to transfer to a four-year institution. Participation in a terminal vocational program often does not prepare students for transfer to a four-year program, thereby limiting their educational opportunities (Witt, Wattenbarger, Gollattscheck, and Suppiger, 1994). Perin (1998) also found that despite enthusiasm for academic-occupational integration, few programs have carried out a comprehensive implementation of the reform, and actual examples are few. She points out that obstacles to integration abound in terms of the cost in time, effort, and expenditures needed for professional development and instructional planning. Other researchers have found persistent concern among faculty in both academic and occupational programs about the use of integrated curricula in their classes, and this concern often translates into resistance to the introduction of such instruction (Dennison 1993, Greene 1993).

These findings show that pedagogical innovation requires changes in more than a few areas, including the organizational culture in educational institutions, the norms of faculty and instructional departments, and the management system to adopt and implement the innovation. This paper thus discusses the process and impact of the ATE innovation from several different dimensions by examining both instructional and institutional factors that directly and indirectly affect the process of curriculum integration.

RESEARCH METHOD AND DATA

This research is based on case studies of ten community colleges housing ATE-funded projects[2]. At each site, the data were collected through semi-structured and conversational interviews with: 1) college presidents and other administrators, 2) college faculty in both occupational and academic departments, 3) the practitioners of the ATE program, and 4) teachers, faculty and administrators at collaborating high schools and four-year institutions.

The basic assumption for our investigation is that the academic and vocational curricula integration is an innovation, and can be examined through the perspective of how the innovation is adopted and institutionalized in educational institutions. To assess the extent of adoption and institutionalization, we followed qualitative methodology oriented toward exploration, discovery, and inductive logic (Patton 1990). Through on-site observations and the investigation of teaching materials, we investigated the substance of STEM curricula as well as how and where the curriculum funded by the

[2] The research project was conducted at the Community College Research Center (CCRC), Teachers College, Columbia University, between April 2000 and September 2002, and was funded by the NSF-ATE program.

ATE program is taught. Through both on-site and follow-up telephone interviews, we addressed such questions as: How do the ATE-funded projects go about involving faculty and departmental chairs in their activities? Are transfer-oriented academic programs or departments integrally involved with the ATE? Does the ATE have any influence on courses in the core curriculum or, at least, on courses outside of the specific occupational area to which it relates? What does the process of integration entail and what barriers to significant organizational change does the ATE staff encounter? Have the ATE projects influenced the procedures and policies for curriculum development and pedagogic improvement?

Interview data were analyzed using QSR Nudist5, a software package designed for qualitative research.

FINDINGS

Curriculum Development

The major activities of the ATE program can be grouped into three areas: 1) The development, implementation, and dissemination of curriculum and other instructional materials; 2) Professional development of college faculty and secondary school teachers; and 3) Awareness and pathway development to interest and recruit high school students into STEM programs in post-secondary programs. All the ten sites we visited had a clear emphasis on the development and implementation of curriculum. The development of curriculum and instructional materials indeed is the basis of ATE activities since the other two activities are usually carried out in a way to implement the developed materials. For instance, professional development usually lies on the extension of

curriculum development where community colleges faculty and high school teachers learn how to use the curriculum. Awareness programs and educational pathways are where the curriculum and other instructional materials are introduced and taught to students.

Table A.1 in Appendix summarizes the activities of curriculum and other instructional materials development at ten sites we studied. Each project focuses on specific occupations or substantive technology including computer and information, bio, paper and chemical, construction, manufacturing, semi-conductor, telecommunications, or agricultural technology. Regardless of the subject areas, the projects utilize unique technologies along with the curriculum and other course materials development. ATE Centers[3] tend to utilize more advanced technologies including online courseware, multimedia, and geo-positioning system. Some projects are using other unique technologies such as 3D animation and computerized instructional boards to promote interest in technology careers. Other projects have created or adopted numerical controlled lab equipment that enables full industry applications.

Five sites we visited have created entirely new curriculum and/or other educational materials to be taught in entirely new programs. Another approach is to use various existing curricula, and integrate them to form several instructional units. This method, called "modularization," was a very popular approach throughout the sites. Modularization, in the area of instructional design, is the development of self-contained

[3] The ATE programs are implemented through two major formats, center and project formats. Centers receive up to $5 million each, spread over four years, while the average grant for a project is about $400,000.

units of curricula that can be combined in different ways[4]. Since faculty members can choose one or more units of the module on a particular subject that they teach, modularized curriculum is easily adopted and is therefore disseminated relatively quickly.

Some projects are involved with the production of skill standards for their industry. They configure and define the skill characteristics of various occupations within the respective industries. These activities are designed mainly to match skills required in industries and those produced in educational institutions in order to effectively develop the skills in demand in the industries. In terms of "use" of skill standards, the ATE programs use such national skill standards as SCANS and SMET for the development of curriculum. But many of them are likely to follow narrowly defined industry – or firm-specific standards, while partially following state and national standards. All projects indeed have obtained significant inputs from local industries. Where industry associations are involved in the ATE-funded activities, industry-wide standards tend to be used. Where individual industries are more or less independently involved in the activities, curriculum tends to be geared toward the specific industries.

[4] The concept of "modularization" originally described a process that permits the manufacture of final products more easily and more cost effectively. This concept has spread into the area of vocational education and indicates a method of teaching that facilitates the use of learning materials in a more flexible and differentiated manner. Rapid changes in technology and skill demand by industry have required this flexibility and differentiation in teaching (Ertl 2000, Laur-Ernst, Kunzmann, and Hoene 1999).

Curriculum Integration: Content Integration and Process Integration

Our focus is on the extent to which academic skills are incorporated into the curricula developed with ATE resources. As mentioned briefly, there are broadly two major approaches involved in the development of ATE curricula. One is to develop an entirely new set of curricula to be used in a new program. Another approach involves "modularization" that assembles new and/or existing units of curricula, which are designed to be incorporated into existing college curricula. In the former case, curriculum integration is a matter of "contents within a new course," that is, how academic and vocational components are combined to form a full program. We call this type of integration, "content integration." In the latter case, curriculum integration has to deal with how the new units of curricula/modules will be integrated into "other" programs in the college. This case involves a continuous process through which ATE modules are gradually integrated into existing courses. In other words, curriculum integration is realized in a process through which the developed ATE curriculum is used by the college faculty and departments. We call this type of integration "process integration."

One example of content integration we observed was the setting up of a new biotechnology program. The college that houses the program has a very strong emphasis on general education, and integrating substantial academic components into the new technology program was a straightforward process. The general education components are concentrated in the first year of the program and include introductory and general chemistry (10-12 credits), introductory statistics (5 credits), Microsoft Office (3 credits), English report and technical writing (3 credits), and general biology (4 credits). From the second year, students start taking courses in industry applications although there are

several general education components remaining. The courses in the second year include: introduction to biotechnology (5 credits), principles of microbiology (5 credits), plant design (1 credit), process support (1 credit), manufacturing technology (3 credits), quality control (1 credit), environmental control (1 credit), validation (1 credit), and human physiology (1 credit). Thus, the total minimum units required for this major are 48 credits, 35 of which are in general education. Students who complete the requirement receive a Certificate of Achievement in Biotechnology. Those who want an Associate in Science (AS) degree in Biotechnology also have to fulfill an additional 20-22 units in general education.

This college was only one of the ten colleges that actually have offered the AS degree through the ATE-funded program. In other colleges, the ATE programs are rather oriented toward technical application, where a technical certificate or an Associate in Applied Science (AAS) degree is offered. In one college, the ATE set up a new program for customized training for a local fiber-optic telecommunications technology company. The program is designed primarily to meet the needs of the company with a few academic ingredients. Academic courses included are: technical mathematics I and II (8 credits for both), English composition (3 credits), and humanities and social science (3 credits) which is elective. All other courses involve industrial applications, including: introduction to photonics (3 credits), introduction to CAET (3 points), electric circuits (4 credits), electric circuits lab (1 credit), computer applications (3 credits), introduction to telecommunications (3 credits), digital electronics (3 credits), physical optics (4 credits), telecom electronics (4 credits), introduction to lasers (4 credits), fiber optic communications (4 credits), technical physics for electronics (4 credits), advanced topics

in photonics (4 credits), telecom manufacturing quality control (2 credits), and advanced telecommunication systems (4 credits). Through the program students can obtain a certificate as well as an AAS in photonics. 27 courses (68 credits) must be completed to obtain the AAS.

These two examples of "content integration" for new programs are the extreme cases—one with very strong academic components, and the other with very strong industry applications. Other cases in "content integration" have a more mixed balance between academic and vocational content. There were two other sites that worked on content integration for new programs. The vocational content in these programs was between 63% and 67% in terms of the number of credits.

The second approach—"process integration"—was more pervasive, and was used at all but one of the sites. In process integration, the ATE curriculum is designed to be used at existing college departments. This means that the ATE has already have faculty who teach the curriculum, and students who learn the curriculum. The ATE thus needs neither to hire instructors nor to recruit students – both of which are usually necessary in the case of content integration for a new program. Lower initial cost in process integration may reflect the popularity of the approach. One example of process integration involves embedding the ATE-funded curriculum in the existing program of engineering, paper, pulp and chemical technology. This project has developed eight modules, which neither replace nor are additions to the existing curriculum, but are designed to be integrated with curriculum in an existing college program. This program has two cores: a general education core consisting of 24 credits, and an occupational core consisting of 48 credits. The ATE curriculum is designed to be infused into the

occupational core curriculum. From the perspective of faculty members in the college program, they import the ATE modules, and then integrate them into the curriculum they had been teaching. Thus the actual curriculum integrators are not the ATE practitioners but the faculty and instructors who teach the program. In order to help the faculty and instructors adopt the ATE modules smoothly, the ATE practitioners focused on the adoptability of the curriculum concept to existing course areas. The curriculum development thus involved a close collaboration with faculty and instructors in the program.

Another example of a modularization approach is at a center that focuses on semiconductor manufacturing. This center has developed about 40 modules for the instruction of semiconductor manufacturing. Each of the modules contains five to eight hours of instructional activity, and includes such content as subject background information, learning plans, animations, PowerPoint presentations, and other educational materials. Clients are faculty and teachers in community colleges and high schools in and around the district. These users customize the combinations of the modules according to their needs. They sequence them, organize them, and use them in different ways, depending on their focus in instruction, or on the needs of local industry. Faculty and teachers thus can use the modules to create their own classroom instruction. In their development, the center paid special attention to the adoptability, customizability, and on-line deliverability of the modules, since these elements facilitate the use of its products.

Regardless of the approaches that the ATE programs follow, we were told at almost all the sites that they have adopted some level of integrated concept of academics

and technologies. Practitioners from two projects particularly emphasized that they explicitly designed their curricula to integrate basic academics and applied technologies. At one project, we were told that their ATE curriculum is: 1) for students, to expose themselves industry' s real applications of specific academic topics: and 2) for workers, to integrate academic subjects in helping them to conceptualize what they do in the workplace. At another project that was developing material for high schools, the ATE curriculum was developed to relate to industry-based skill standards, SCANS, and state-mandated academic standards, thus incorporating academic, technical and employability topics.

Nonetheless, the development of integrated curriculum is not the end of the story. The curriculum has to be taught and learned, and thus has to be disseminated to actual instructional sites. In this stage, the two different approaches, "content integration" and "process integration," tend to yield different impacts on STEM education as well as on the career pathway of STEM students. For instance, in the case of content integration, new programs that use the ATE curricula usually do not have interaction with other programs and departments once the program is in operation. During the designing of the curriculum, the ATEs may draw on curriculum experts from different college departments outside the ATE. But once the new program enters into operation, the curriculum is usually taught only within the department that houses the program. Dissemination of the curriculum thus depends on the extent to which the new program can attract new enrollment to the program. To the extent that the program is standalone, the department that houses the ATE program designates the type and extent of the impact. For instance, if the program is located in a non-credit unit such as the workforce

development program, it rarely offers opportunities for students to transfer to advanced degree programs since non-credit programs do not usually interact with academic programs on offering academic, transferable credits.

The "process integration" approach, on the other hand, is designed to facilitate interactions with different college departments. The more the ATE curriculum is used by faculty from different departments, the greater the dissemination of the curriculum. By the same token, in process integration, the nature of the impact of the ATE on curriculum integration is largely affected by what instructional department is involved in the ATE program. For instance, if general education faculty adopt and utilize ATE curriculum in their department, the integration of academic and vocational instruction is highly likely. On the other hand, the use of ATE modules in a workforce development program would not contribute much to the integration. In terms of a relation to transfer, greater involvement of general education faculty tends to result in a course alignment that provides greater opportunities for transfer.

Thus, for the integrated curriculum to be really integrated into the college programs and to impact on transfer from two-year and four-year programs, the location of the ATE program as well as who are involved in the development and use of the ATE curriculum are major issues to be investigated. The next section examines in detail the relation of the ATE to other programs and departments.

Relation to the College Faculty and Departments

Collaborations among faculty members, particularly from different departments, are important for at least two reasons: The first concerns program quality. As more of the

college faculty and departments are involved in the ATE, incorporating the strengths of different programs can enhance the ATE program of instruction. For example, input from academic faculty on basic math and science, from occupational faculty on technical or applied subjects, and from faculty in workforce development on business and industry, make the instructional materials effective for both work-bound and four-year program-bound students. The second reason concerns the scope of dissemination. There is no question that the more the faculty in different departments are involved in the curriculum development, the greater the potential of the curriculum being disseminated into different departments in the college.

In an attempt to explore how the ATE has been able to involve faculty members from outside the ATE, we examine the participation of faculty members in four major areas of ATE-funded activities including: 1) the development of curriculum and other instructional materials; 2) the implementation of curriculum and other instructional materials; 3) professional development; and 4) career awareness and pathway development. We first look at the involvement of faculty members in technology/occupational programs, second, in general education programs, and then in non-credit, workforce development programs.

Technology/Occupational departments

The participation of technology/occupational faculty members in the development and dissemination of ATE-funded curriculum as well as other ATE activities is pervasive. As Table A.2 in Appendix shows, at nine out of ten sites we investigated, occupational faculty was participating in almost all types of ATE activities. Whether the principal investigators (PIs) of ATE-funded projects are faculty members in occupational

departments or not, the ATE projects are collaborating extensively with the faculty of the occupational departments. Faculty members of occupational departments are often the Co-principal investigators for the ATE programs. The ATEs are particularly successful in inviting the participation of occupational faculty for the development of the ATE curriculum as well as the implementation of the curriculum. The ATE projects call these faculty members "subject matter experts," and expect them to support the dissemination of the ATE instructional materials into the existing occupational curriculum. Accordingly, the ATE curricula and other instructional materials are implemented smoothly in professional development for occupational faculty, and the participation of the faculty in career pathway development is also promoted.

Most occupational faculty we interviewed told us that the ATE is useful for their departments. They often use the program as a resource for their instruction as well as professional development. At one college, faculty members said that the center activities: "are a complement to what we are doing in our department," "are helping us to gain cutting edge in technologies," "are allowing students to use the technology in advance," and "are enabling us to exchange information with community colleges that the project is partnering with." Faculty also said that "through innovative instruction, students feel that they are enrolled in a superior school," and "the college has a great pride in such innovative ideas and activities."

General education department

We found that the participation of general education faculty is far less common than that of occupational faculty. Five projects reported that they interacted or tried to interact with faculty of general education programs. At four of these sites, faculty

members in general education provided inputs for the substance of the ATE curriculum during its development. There are two colleges that have strong emphases on general education; at one of these, the ATE program is located in an academic department. In that case, the academic faculty alone developed the curriculum with the industry partner. At another college, there was also strong involvement by academic faculty in the development of the curriculum. In two additional cases, the academic faculty did provide some input, but did not actually develop the curriculum.

In Table A.2, we can see that, while general education faculties were involved in curriculum development at four sites, this involvement did not lead to the "use" of the curriculum in their academic programs at three of these sites. The users of the ATE curriculum are predominantly those in occupational programs. This means that there is an effort among occupational faculty to integrate academic content into technology curricula at occupational departments, but not vice versa.

The same picture is observed in professional development. Faculty members in general education programs are involved in professional development at only two colleges. At college C, only one academic faculty member was involved with the project. Professional development is a continuous activity through which the initiative of the ATE is disseminated to and imbedded in the rest of the college. This sparse involvement of general education faculty in professional development shows not only that the exposure of academic faculty to the ATE curriculum is very limited, but also that any influence that the ATE programs might have on the academic departments would be limited.

Accordingly, there are few general education faculty members who are involved in awareness and career pathway development. General education faculty participates in

awareness and pathway development only at two sites. At one site, only one faculty member is a participant. This fact has an important implication for the issue of articulation arrangement between the ATE-funded programs and 4-year programs. Sparse involvement of academic faculty in pathway development implies a weak link between students in the ATE programs and the processes and activities that lead to transfer from the community college to four-year institutions.

Consequently, although there were five sites where faculty from four-year schools were involved in curriculum and professional development, there was only one project where these faculty participated in career awareness and pathway development. The remaining faculty members from four partner colleges provided their expertise only on subject matter. They did not assist in any further development of the programs, such as establishing pipeline and/or program alignment, nor do they act, for instance, as intermediaries between community colleges and their universities.

Non-credit programs

Our investigation has revealed that interactions between ATE-funded programs and non-credit oriented workforce development programs[5] are prevalent, and have been increasing. Where the ATE is located in an occupational/technology division, the use of ATE curriculum and other instructional materials has been shifted or expanded to the division of workforce development. Where the ATE is located in a non-credit program, there is a quick and smooth expansion of the use of the ATE curriculum. There is furthermore, a trend towards the ATE programs themselves relocating to the workforce

[5] Workforce development programs are designed to serve industry clients primarily: offering contract type education and training, short-term certificate type programs, and sometimes, consulting. When the programs offer credits and degrees, they do so through arrangements with other programs within the colleges.

development divisions or departments. For instance, one of two ATEs that are currently located in the workforce development division came from a technology department after two years of operation. In addition, two other projects that are currently located in occupational/technology departments have been planning on moving to workforce development divisions. There is thus an emerging trend of implementing the ATE program in the area of workforce development, particularly in short-term non-credit-type programs and contract training.

Rather than integrating ATE curricula into existing instruction in academic as well as occupational programs, the ATE programs we visited have become more likely to set up a standalone program at a workforce development unit. When the ATE is operated under workforce development, there is a very limited academic ingredient in the program. Thus, neither "process integration" nor "content integration" occurs in the workforce development program. Rather, the ATE program at workforce development focuses on industry application through a close tie with industry partners. We indeed saw a very strong involvement by industry partners in all areas of ATE activities including curriculum development and dissemination, professional development, awareness and career pathway programs.

Based on observation of the ten colleges we visited, the involvement of academic faculty is mostly in the development of curriculum and other instructional materials. For continuous activities such as: 1) the implementation of the ATE-funded curriculum and other instructional materials, 2) professional development in the use of such materials, and 3) awareness and pathway development where such materials are used, faculty from occupational programs and workforce development programs as well as industry

representatives are the major players. This result shows that the ATE program has had little impact on instruction in the general education or academic subjects: The ATE is seen primarily as a reform in vocational programs, but not in academic programs.

Why the Weak Relationship with Academic and the Strong Relationship with Vocational Programs?

What barriers, then, thwart deeper and more extensive interaction between the ATE-funded program and academic faculty and departments? Why is the program more likely to be in the vocational division, and then further moved into the non-credit mode of instruction? For the first question, we have identified two major issues: One is over the substance of instruction; and the other, over organizational issues such as work arrangements. For the second question, we found that the movement of the ATE program to being an industry-oriented program is due largely to the strategic decisions of the college to maximize the benefits of operating the technological program closely with industries while minimizing the possible cost of running the ATE program in credit-based programs, particularly in an academic department.

Issue of pedagogy and instruction

Because of the technicality of the ATE program, occupational departments are more likely to initiate the ATE activities. While the ATE evolves as an occupational program, ongoing tensions tend to occur between the ATE and the academic departments. At five colleges, at least, we have identified a sense of concern that the ATE project was too dominated by the vocational areas of the institution. The Vice President of Academic Affairs at one site describes the ATE: "There' s an institute in there [the engineering

technology] that's mainly training. Most of the stuff is mainly training." Then she comments on the lack of academic instruction that causes problems for students if they want to transfer to an advanced program.

> *"Every certificate and degree on offer has to have certain academic courses. We try very hard not to have a certain English course for this major and another English course for that major. Everybody needs to take freshman college English, composition and rhetoric... What has caused trouble is that engineering technology creates their own little courses in order to bypass regular courses. For example, a [applied] math course is introduced so that students can bypass the regular math requirements. This creates a problem for us. There is no special math for engineering technology, no math for English, no math for science majors, it's math. And so math is very integrated and as a result students get a very good education in math. But the engineering technology folk are bad about trying to extract and teach only the applications and not the theory. And that's going to be bad for the student when they transfer because they're not going to have the necessary background but they're going to have the "A" on their transcript."*

At another college, academic faculty is concerned about the quality of teaching offered through the ATE program.

> *"They have hired faculty that have an A.A. degree in the subject they are teaching. And that's a considerable break, because usually most of us have a masters or higher degree. I think staff is being hired for their expertise in a particular area, but they don't have any pedagogical or educational background. You have people that have never taught, but they have expertise in Photoshop or some media program...but they don't have declarative knowledge of the steps that are required to get some information from their brains to student brains."*

These criticisms by academic faculty, however, do not translate into an interest or commitment to teaching on ATE programs. Individual liberal arts faculty may be recruited to work on some of the programs, but as a whole, academic faculty who want to follow traditional pedagogical values, and who focus on academic transfers to four-year institutions, tend to be skeptical about curricula that aim to integrate technical content

into general education. One faculty member describes this situation as a "turfish" or "territorial" issue. The faculty member says,

> *"Many of us who adopt a holistic perspective on curriculum find ourselves uncomfortable. The ATE program would be far more compatible with vocational program than with an academic program that has a transfer emphasis. Hence there are times when we get a bit turfish and territorial"*

Resistance to the ATE program among academic faculty is particularly strong in colleges that have a strong liberal arts tradition. In some cases, the ATE program is located outside the traditional instructional unit because of anticipated hostility from academic faculty. One college has an ATE in the Business and Industry Division, and the ATE maintains a clear distance from the academic department. The president of the college pointed out that if the college inclined to industry-oriented instruction, there would be strong resistance from college faculty:

> *"We do not have industry-focused programs. This is our approach. Even in electrical technologies, engineering, whatever, they are all AS degrees. There is very strong tradition here… this is a history founded by a founding president of this college. There is a sense of this will be a liberal art college…. There is no customized program. If we have, there is a lot of resistance. 'We don't do that.'"*

Thus for this college, the ATE is an industry-focused program, which has to be operated independently within the division that focuses on workforce development. This program had been tested at local high schools when we visited the college, and has encountered resistance also from the academic teachers in the high schools. While this project focuses on 2+2+2 pathway development, it has difficulty in disseminating the ATE curriculum in high schools, where there is a strong resistance to applied curricula. For example, one college faculty member reported that a physics teacher who did not want to discuss the new curriculum module rebuffed him because the teacher preferred to

teach a traditional physics program. Also, the project team tried to initiate summer workshops, but failed as a result of the opposition from high school teachers. In another instance, chemistry teachers were frustrated when a presentation of their newly developed lab modules was not well attended during the district's professional development day. The PI informally acknowledged that this difficulty might have resulted from a lack of interest in applied chemistry instruction.

In fact, in most colleges, it was difficult or took extra days for us to arrange interviews with academic faculty. A dean of workforce development analyzed and criticized these unbending attitudes of academic faculty as follows:

> *"I believe that the academic division students are in much greater need of technical skills than the technical students are of academic skills. We recognize the need for them to have communication and computation skills. But we have many academic students who are in programs like English or Drama or other non-technical academic programs that leave here with an Associate's degree, still wondering what they're going to do with their life, and frankly they're unable to do much. So integration, I strongly support integration of academic and technical curricula, but I'm not sure which divisions of this college are in greatest need of it."*

This remark, which indicates frustration on the side of workforce development with academic programs, underscore the fact that barriers to change can exist among both academic and non-academic teachers and faculty.

Issue of work arrangements

Another major issue is on organizing the ATE program with, or within, the departments that house the program. When the ATE is independent of the core function of the college, faculty consider it an extraneous entity that neither bothers nor benefits them. But as the ATE becomes closer to these faculty members, various anxieties emerge over work arrangements. Such a development tends to generate anxiety about a cross-

subsidization that could potentially reduce resources available for the college's academic functions. Another concern involves faculty staff numbers if and when academic members take release time to work for the ATE.

The development of the ATE program at one college has resulted in organizational change at the department of biology. This transition has faced considerable resistance. At this ATE program, the PI and Co-PI are department faculty. They have been able to buy out of teaching most of their courses while they are working on the grant. A faculty member in the department says that the ATE imposes a "big penalty" on the department because the department loses faculty headcount when they take release time to work for the ATE. The department has hired a lab assistant, and has shared two students' counselors with other departments for the ATE program. A faculty member who had also served as department chair informed us that the program had not been able to add a new faculty line in the past few years because the ATE program was costing the school too much. This faculty member also says that he is not interested in participating in the ATE project, saying that the ATE program is "fine for somebody else," but he does not want it at his college. Meanwhile, both the PI and Co-PI told us that they would not renew the ATE grant since the work involved in applying for, and managing, the grant imposes a significant extra workload on them, and they just cannot handle both their faculty and ATE responsibilities.

Different pay schemes are another issue that tends to cause friction between the ATE and the rest of the college. At one ATE center that focuses on information technology, some faculty is hired at higher salary levels. Interviews with a faculty focus group, outside the center, revealed that they understand that IT skills are competitive and

accordingly those in the center receive a higher salary. But they say that the difference in employment schemes isolate the ATE center form the rest of the college not only physically but also emotionally. One of the faculty described the situation of a media communications working at the center as follows:

> *"They sometimes feel like they are walking around and people have bull's eyes on them. At one point, technology was a big bugaboo here, and people sort of had a knee-jerk reaction to anything that sounded like technology. It was a threat to the college... There are a lot of issues..."*

At another college, the president says that she is always "in the position of explaining that the money for the project is not the same as the faculty money" implying that the faculty does not want the college to subsidize the ATE.

Forces Leading the ATE toward Non-credit, workforce development programs

The above discussions focus on why the ATE program tends to be located at a distance from the academic unit of the college. Why then do more of the ATE-funded projects move into workforce development divisions and get closer to the industry side? Through interviews with ATE practitioners, college administrators and industry representatives, we identified three major reasons:

1) Advanced technologies that the ATE deals with change rapidly. In order to constantly update the knowledge of such technologies, and to respond to industry requirements quickly, the ATE needs to be located in a place close to the industry.
2) By not locating within the credit part of the college, income from non-credit programs can be retained by the program free from the control of general education funds, thereby allowing the ATE to raise an operational budget.

3) Particularly in colleges with a strong liberal arts tradition, the unit of workforce development is operated independently from the instructional units of the college. Locating the ATE at the workforce unit allows the ATE flexible and close communication with industry while the college can maintain its liberal arts culture.

The colleges have decided to locate the ATEs to non-credit, workforce development programs due to one or more of the above reasons. There was an ATE project that changed the organizational location of the ATE during the course of operation. This change showed us clearly why the ATE tends to prefer the workforce division to the academic unit. In this college, the ATE started at the division of engineering technology. The dean of the division was the PI of the ATE, and he was reporting to the vice president of academic affairs. After two years of operating with engineering technology, the ATE was moved to the program of workforce development. The dean of engineering technology as well as the PI of the ATE is now reporting to the vice president responsible for workforce development.

The president of this college sees engineering technology itself as a program that should be separated from the academic unit of the college. He says:

> *"I moved it [engineering technology] away from the vice president of academic affairs because: 1) she did not understand it, 2) exactly because they didn't want to dirty their hands with it, and 3) the fact we look at technology and engineering technology as academic programs is really like how exactly we view nursing, like a separate distinct entity in a lot of different respects. And their workload model is different. They're working on Saturdays, Friday nights and the traditional transfer faculty . . . wouldn't even think about doing that. And so it's been integrated underneath Continuing Ed, which has really became workforce development."*

The president also explained the driving forces behind the shift to workforce development. While this project focuses on IT and telecommunications, due to rapid technological changes and increasing competition in this area; the college needs to respond more quickly to the needs of industry. "The college has to keep close business connections, and to provide timely services," the president said. Also more industries are demanding certificate programs, and flexible applied programs tailored to specific technology or industry needs. The separation from the academic programs allows the ATE to act flexibly in order to meet industry requirements. Through workforce development, the ATE now offers a wide range of programs including non-credit courses, contract-type training as well as certificate and specialist programs.

There was also an issue of financial convenience that drove the ATE to a non-credit mode. The research team conducted a phone interview with the PI a year before the actual visit to the college. This interview revealed that the PI, when the ATE was geared toward a credit program during the first two years, faced critical restrictions and problems within the academic department. He reported that when the project is located in an academic department, money goes into the general education fund and then is distributed throughout the college. As the ATE activities and objectives grew, it became difficult to operate the ATE within the budget distributed from the general education fund. In addition, while the ATE was working in a credit mode, they were restricted by state law as to how much they could charge business for training. The PI judged that for their activities to be sustainable, structural distance had to be established between the ATE program and the college. The problems of funding and state restrictions were then eradicated.

Finally, because of the applied curricula that the ATE is promoting, colleges that emphasize general education tend to have greater difficulty locating the ATE in the traditional academic part of the college. While partnership with industry is one of the key features of the ATE program, the college, through the medium of economic development, allows the ATE to interact with industry while maintaining its liberal art culture.

Thus, the separation of the ATE from the traditional academic department is a result of specific considerations to allow the ATE to evolve smoothly and easily in the two-year colleges. This, in turn, confirms that operating the ATE within an academic department is challenging in terms of its relationship with industry and the financial and organizational coordination. The ATE appears to be evolving smoothly as a workforce development program. But it is clear that a move to workforce development format signifies a weakening emphasis on the integration of occupational and academic education.

Implication for Articulation and Transfer

We have discussed: 1) a pervasive involvement of occupational departments in ATE programs; 2) little substantive and ongoing interaction between the ATE and academic departments; and 3) an increasing trend of the ATE program moving toward a non-credit and workforce development emphasis with weak academic content. What is the implication of these findings for the issue of articulation and transfer? We have discussed two major approaches to the implementations of the ATE curriculum. One is to use the curriculum in a new program within a specific department; the other, to integrate the curriculum into existing college instruction. Where new programs were set up, two

cases are in the existing instructional departments while three cases have been offering new programs as workforce development programs. In the former case, the programs are new, but the instructional departments that the ATE programs belong to largely affect the transferability. In the latter case, there is literally no transferability.

The second approach, what we call "process integration," is adopted at nine of the ten sites we investigated. In this approach, the college faculty and departments that use the ATE curriculum are the curriculum integrators, as discussed previously. Thus the transferability of students who learn the ATE curricula/modules is closely related to the instructional departments that house the ATE program – whether the departments facilitate articulation arrangements, and whether the ATE curricula have affected such articulation arrangements. This section thus focuses on how the college departments that house the ATE program see the transferability of their curricula that incorporate ATE modules.

When we visited, the ATE-funded curricula were being offered for students at seven out of ten colleges. Except for one site, these programs are designed to offer the Associate of Applied Science (AAS) degree, which is intended to prepare students for immediate entry to the workplace. Most of these colleges also offer certificates and specialist diplomas. In these colleges, there had as yet been no report of any student transferring directly to a 4-year program. One exception was students who studied through the ATE module and advanced to the Bachelor in Applied Science (BAS) program at a nearby state university. In this college, an articulation agreement has been set up between the college that houses the ATE and the state university, particularly for AAS students to come into the BAS program.

In most of the departments that house the ATE program, articulations are potentially possible. They have agreements with one or more local universities. The ATE PIs report that the course that teaches the ATE curriculum could be part of the articulation agreement, or that they are working to participate in the agreement. Nonetheless, they all report that students would need to take some significant amount of additional courses in general education in order to transfer.

Programs that offer degrees have, to a greater or less extent, a combination of applied and academic classes. A college that has a strong emphasis on general education has a greater amount of academic content also in the ATE-funded program. In other colleges, the percentage of the general education content, where it is available, is much lower. The general education courses in these colleges are generally not transferable to four-year institutions. With the ATE programs, students usually take "applied general education" such as "applied chemistry" or "applied mathematics" that are classified specifically for students in occupational or technology type programs, and are not transferable to four-year programs.

To the extent that the academic courses that occupational students take are not transferable, this creates problems for those students who become interested to advance to four-year programs during the course of their study at the 2-year institution. One faculty member we interviewed stated the problem as follows:

> *"Some students just start with a community college. While they are in the college they discover that they can be successful and they'd really like to do something, perhaps they get a goal in life that would require them to have a four year or bachelors degree. Well, if they've come into the community college in a voc. tech. program, then much of what they have taken will not transfer to any four-year institution for a bachelor's degree because the credits are not compatible. So they already have trouble... if they really want to pursue that goal and transfer to the institution, they realize that they've lost one or two years. Because very little of*

what they've done will work. So it takes them a lot longer to get a bachelors degree than they think it should, and they spend a lot more money, and borrow a lot more money, and that type of thing. Very disappointed, quite a bit of disappointment."

Asked about the difference between "applied general education" and "academic general education," faculty members in occupational programs generally reply that the substance of the courses is basically the same. So two basic questions should be addressed: Why then is the general education in occupational programs not transferable? And why are students in academic and occupational programs not sharing the same academic courses?

To these questions, we were told that these two types of general education curricula have almost identical content, but are "intended" differently, one for transfer students and another for vocational students. This is because people (in occupational and in academic-oriented areas) learn things differently, and "one size no longer fits all." One faculty member says,

"Some people are very applied, and if they can't apply it to what they're doing in their everyday lives... Johnny just wants to go back to the farm, but he has to take chemistry, then he will take applied chemistry, no need for Chemistry 101."

There are at least three sites where PIs or college faculty in departments that house the ATE say that their students in occupational programs basically do not intend to transfer, and thus they rarely guide students to take general education in academic departments. At two sites out of these three, there is no one who has moved from occupational to academic programs aiming at transfer. At one site, only six out of 620 students in the occupational department that houses the ATE have been taking classes in academic programs.

We mentioned that there was a new biotechnology program set up within an academic department, and the curriculum has substantial general education components, which are transferable. This program, however, has experienced a significant shortfall in the number of students involved. In this program, the general education components are concentrated in the first year of the program, and industry applications, using the lab, take place in the second year. It is likely that students who seek jobs in biotech manufacturing have found it difficult to complete the academic courses before reaching the application components of the program. In a follow-up interview about one year after the actual visit, we in fact heard that the program has modified the course design, allowing students, particularly those from industry, to skip the academic courses. This shows that the single project that allows a full transfer of academic credits has been also moving toward a non-transferable, industry-oriented program.

The transferability of the students who go through the ATE program should thus be considered from several perspectives. To what extent should the ATE be regarded as a technical versus an academic program? How and by whom should the ATE curriculum be used? What type of coordination is necessary to improve the transferability of a program that has both technical and academic elements? It should also be remembered that the mindset of both academic and technology faculty could often be a barrier that impedes the dissemination of new concepts and activities.

CONCLUSION

In this study, we identified cultural, instructional, and organizational barriers to a federally funded pedagogical innovation, a finding consistent with many previous studies

in academic and vocational curriculum integration. The ATE projects do emphasize an integrated approach for the development of their curricula and other instructional materials. But in terms of the structure through which these curricula and instructional materials are implemented and disseminated, the ATE-funded programs have not been delivered in such a way as to promote the widespread application of academic and occupational curriculum integration, and to facilitate transfers from two-year colleges to four-year institutions. There were traditional tensions between the academic and occupational departments that negatively affect the implementation of an integrated instructional pedagogy. The trend is an increasing implementation of the ATEs at non-credit workforce development programs where there is literally neither curriculum integration nor transfer to advanced degree programs.

Why do the ATE-funded projects encounter academic versus occupational tensions, and why are they unable to overcome them? Why do some of the ATE-funded projects that were already at a distance from the academic units of the college further separate themselves from these units, and move closer to non-credit and workforce development units? For some projects, the answer to these questions is that they are attempting to better serve the industry clients of the community colleges that house the ATE program. Academic emphasis is often seen as reducing flexibility to respond to industry needs. Other reasons mentioned by college administrators are managerial ones. By not locating within the credit part of the college, for instance, income from non-credit programs can be retained by the program, free from the control of general education funds, allowing the ATE-funded program to raise an operational budget. Also since non-

credit type programs are relatively easier to set up and withdraw, these programs incur lower risk while flexibly responding to the needs of industry.

Why is there often no interest among faculty members in the integral instructional approach? In academic departments, there are still many faculty members who do not agree with pedagogy that integrates academic and technological components. For many emerging technologies that the ATE program supports, there are few two-year colleges that possess the requisite technical expertise. Thus the ATE-funded projects need substantial support from industry. The greater presence of industry in the teaching field may cause academic faculty anxiety about the survival of their traditional teaching practices. But lack of interest in integrating academic science and technology education is not only a factor with academic faculty. There are many technology faculty who don't pay attention to academic mathematics and science as programs that provide greater opportunities for their students. We were often told: "Students who come here do not intend to go on to a 4-year program." Where students are industry employees this perception is even stronger. The term that technology faculty use for the education of these students is "retraining," the raising of occupational skills, not the facilitation of potential to go on to advanced educational opportunities.

At every college we visited, the president and senior administrators affirmed their strong support for the ATE-funded projects including innovative curriculum development and implementation. However, except in a few instances, the colleges do not give incentives and direction strong enough to overcome the traditional tension between academic and vocational instruction. The implementation of the ATE-funded curricula as well as professional development is sporadic rather than systematically geared toward a

specific goal. These efforts tend to be spread outward, and where and when those making them encounter resistance or other circumstances that discourage them from going further to diffuse the innovative curriculum, they retreat, and change direction towards where such efforts are accepted easily. This signifies an increasing trend of the ATE-funded projects moving toward a non-credit and workforce development emphasis with weak academic content.

For educational administrators, this study emphasizes the importance of organizational structure that significantly affects the implementation of innovative activities. For educational researchers, the study suggests the need of further studies on the effectiveness of vocational and academic integrated instruction as well as the means and rationales to implement such instruction.

Appendix

Table A.1. Characteristics of curriculum and other instructional materials development

College	(1) Subject area and technology	(2) Major products	(3) Created new courses	(4) Modulari-zation	(5) Re-packaging	(6) Skill standard	(7) Industry input
A (C)	Information technology	Online course-ware	X	X	X	X	X
B	Bio-technology	NC lab & curriculum	X				X
C	Paper, chemical and others	Integrated curriculum		X			X
D	Construction	Integrated curriculum		X			X
E	Paper, chemical & plastics	NC lab & curriculum		X			X
F	Manufacturing	Simulation module		X	X		X
G (C)	Semi-Conductor	Multi-media course-ware	X	X		X	X
H (C)	Tele-communicatio n	Text book & CD	X	X			X
I	IT, Telecom, and others.	Inter-college curriculum		X			X
J (C)	Agriculture technology	GPS/ GIS module	X	X	X	X	X

Table A. 2 Faculty participating in the ATE activities

Activities	A (C)	B	C	D	E	F	G (C)	H (C)	I	J (C)
Curriculum development										
Occupational	X		X	X	X	X	X	X	X	X
Gen. education	X	X	X	X						
Non-credit			X						X	
Teaching the curriculum										
Occupational	X		X*	X*	X	X*	X	X		X
Gen. education		X	X*							
Non-credit			X		X**	X**	X	X	X	
Professional development										
Occupational	X		X	X	X	X	X	X	X	X
Gen. education			X	X						
Non-credit			X				X		X	
Awareness and career pathway development										
Occupational	X		X	X		X	X	X	X	X
Gen. education			X	X						
Non-credit			X			X**			X	

X* indicates that the program is designed to be taught by the faculty but that is not yet realized because the program is currently being implemented only in high schools.

X** indicates that the program was planning to use the ATE curricula at workforce development program soon in the future.

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